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ESTIMATED COST AND EQUIPMENT FOR COMMERCIAL PRODUCTION OF POTATO FLAKELETS

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SUMMARY AND CONCLUSIONS

A process has been developed using drum dried mashed potatoes to make a new dense product called flakelets. Mashed potatoes made from flakelets have the same desirable properties as do those made from the well known potato flakes of commerce. However, the bulk density of flakelets is more than double that of flakes. Because of the greater density, a No. 10 can will hold about 5-1/4 pounds of flakelets, resulting in a saving of 3 cents a pound of product in the cost of the packaging materials. Although there are more processing steps in the making of flakelets, the cost of the additional steps is more than offset by the saving in packaging. The estimated cost to make is 26-1/2 cents a pound for flakelets and 28 cents for flakes. The higher density of flakelets enables their economical packing in nitrogen, with or without antioxidant. Even if flakelets are packed in nitrogen, their production cost would be 27 cents a pound, or 1 cent a pound less than flakes packed in air. Flakelets absorb water on reconstitution to such an extent that for any desired volume of mash about 12% less weight is required than for most other forms of dehydrated mashed potatoes.

ESTIMATED COST AND EQUIPMENT FOR COMMERCIAL PRODUCTION OF POTATO FLAKELETS

J. B. Claffey, R. K. Eskew, and F. H. Drazga

I. INTRODUCTION

A process for preparing a dehydrated mashed potato in flake form, capable of reconstitution to a product having good flavor, color, and texture has been described (1, 2, 3, 4, 5, 6, 7)[*]. Another publication issued in 1956 gave the estimated cost for producing flakes. (8). However, flakes have a relatively low bulk density. When cut or broken into pieces, typically about 1/2 inch square, their bulk density is about 14 pounds per cubic foot. This low bulk density produces a package that has excellent sales appeal for the retail market, but the bulk excludes the use of flakes by the military forces and at least to some extent, limits their use in the institutional markets. There has long been an incentive to make a dense product that would yield a mash equal in quality to that obtainable from flakes but which would be better adapted than flakes to institutional and military use. Such a product should be capable of economical nitrogen packing without the use of antioxidant if desired.

This publication describes a process for making a product termed "flakelets", having a density between about 46 and 50 pounds per cubic foot. Contrary to the implication of the name, the product is not small flakes. It comprises laminates, and aggregates of fragments, a few individual potato cells, and some cell agglomerates. Its consequent bulk density is far in excess of what can be obtained by merely reducing flake size. On reconstitution flakelets yield a mash possessing the good color and flavor of a mash resulting from flakes. Generally the mash from flakelets possesses a somewhat lighter and fluffier texture than that from flakes. Because of the higher density a No. 10 can will hold about 5-1/4 pounds of flakelets. Moreover, flakelets absorb more water when reconstituted. Flakelets absorb water on reconstitution to such an extent that for any desired volume of mash about 12% less weight of product is required than for most other forms of dehydrated mashed potatoes. A No. 10 can of flakelets may well yield the same number of servings as a can of granular potato product.

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[*] Numbers in parentheses refer to Literature Cited, p. ~~40~~ 36.

The development work on flakelets has been described in previous publications (9, 10).

Costs are also included here for flakes in order to obtain an estimate consistent with current prices and practices. A comparable cost estimate for flakelets is given. This shows that flakelets can be made more cheaply than flakes.

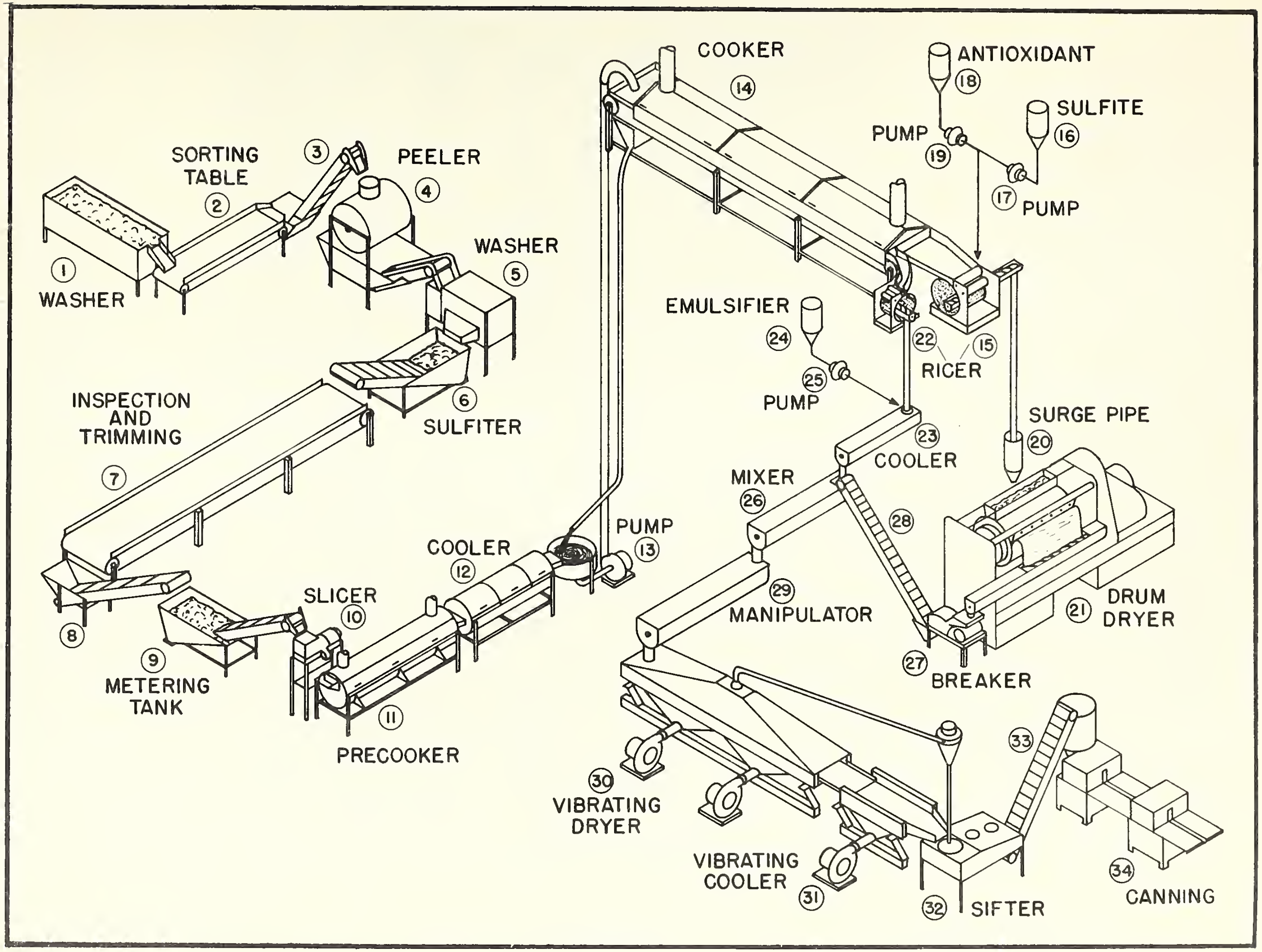

Fig. 1. Potato Flakelet Process

II. DESCRIPTION OF PROCESS

Figure 1 is a flow sheet of the flakelet process. The initial steps are those used in making flakes, but after cooking, the slabs are divided into two streams. One of these, comprising about 93% of the total product, is drum dried to about 8 to 10% moisture, the sheet is broken and combined with the undried material to give an average moisture of about 30%, depending on the variety of potatoes. This mixture is manipulated in such a way as to laminate and compact the fragmented drum-dried sheet to give a product which when dried has a bulk density of about 50 pounds per cubic foot.

(A) Peeling and Trimming

Facilities are provided to condition the potatoes for 7 days at 70°F. when necessary to reduce their sugar content. After washing (Item 1), the potatoes are passed over a sorting belt (Item 2) for the removal of stones, and peeled (Item 4). A lye peeler was used in the pilot plant; however, disposal of spent lye from commercial plants is becoming a problem in some parts of the country. Steam peelers, both batch and continuous, are used in the commercial production of flakes, and could also be used for flakelets. The cost of a batch steam peeler was assumed in this estimate without implied preference of batch over continuous peelers. From the peeler the potatoes are washed to remove skins, (Item 5), dipped in sulfite solution (Item 6), and trimmed (Item 7). Some potato plants do not have a sulfite dip when steam peeling is used; the cost of a sulfiter, however, is included in the estimate.

In a previous publication (8) it was assumed that complete trimming was necessary, requiring one trimmer for 500 pounds per hour of potatoes. Subsequent plant operations have shown that this thorough trimming is not necessary since traces of peel which are left on the potatoes accumulate on the last roll of the drum dryer, from which peel can be periodically removed. Current practice is one trimmer for every 1,500 pounds per hour with possibly additional trimmers late in the season when the potatoes are more difficult to peel. Thus the trimming costs shown here are based on 1,500 pounds per hour per trimmer.

(B) Precooking and Cooling

Trimmed potatoes are metered (Item 9) and cut into slices about 1/2 inch thick (Item 10). It is advisable to use a small stream of water in the slicer to flush away free starch. The slices are precooked (Item 11) by immersion in water at 160° F. for 20 minutes to gelatinize the starch, and are subsequently cooled (Item 12) by immersion in water, preferably below 50° F., to retrograde the starch. A 20-minute cooling time is usually adequate, but late in the season, depending upon the water temperature and the type of equipment used, 40 minutes may be required. The estimate allows a 40-minute cooling time. Water from the cooler (Item 12) can be utilized in the washers (Items 1 and 5).

(C) Cooking

The slices are pumped (Item 13) to the cooker (Item 14), which can be located overhead in a penthouse on the main building. Pumping, rather than conveying, minimizes the time of exposure of the potatoes to air (since they are submerged in water during transfer), hence avoids discoloration. Pumping with water also washes free starch from the cut surfaces. The slices should be cooked just soft enough to rice. The two previous steps of precooking and cooling increase somewhat the time required for cooking. The shortest time experienced in the pilot plant for adequate cooking was 30 to 35 minutes for Idaho Russets and the longest time 45 to 50 minutes for Maine Katahdins. Cooking at higher elevations would increase the necessary cooking time. (It will be realized that up to this point the process for making flakelets is the same as that used in making flakes, figure 2).

(D) Proportioning and Ricing

In making flakelets, approximately 93% of the cooked potatoes are riced (Item 15), dried on the drum dryer (Item 21) and the product after it is broken is mixed (Item 26) with the other 7% of the cooked potatoes. For Western Russet Burbanks containing 21% solids the mixture should have a moisture content of approximately 30%, and this figure is used in the estimate. The proper moisture will depend upon the variety and solids content of the potatoes. In most cases it will lie between 28 and 32%. If the moisture is too high, hard balls of mash are formed which are difficult to disperse; if too low, the pieces merely break instead of laminating and the bulk density of the product will be lower.

The ricer (Item 15) of some manufacturers may need modification to yield a mash with a minimum of cell rupture. One satisfactory ricer has a spiral screw which forces the cooked potatoes through slots at the discharge end.

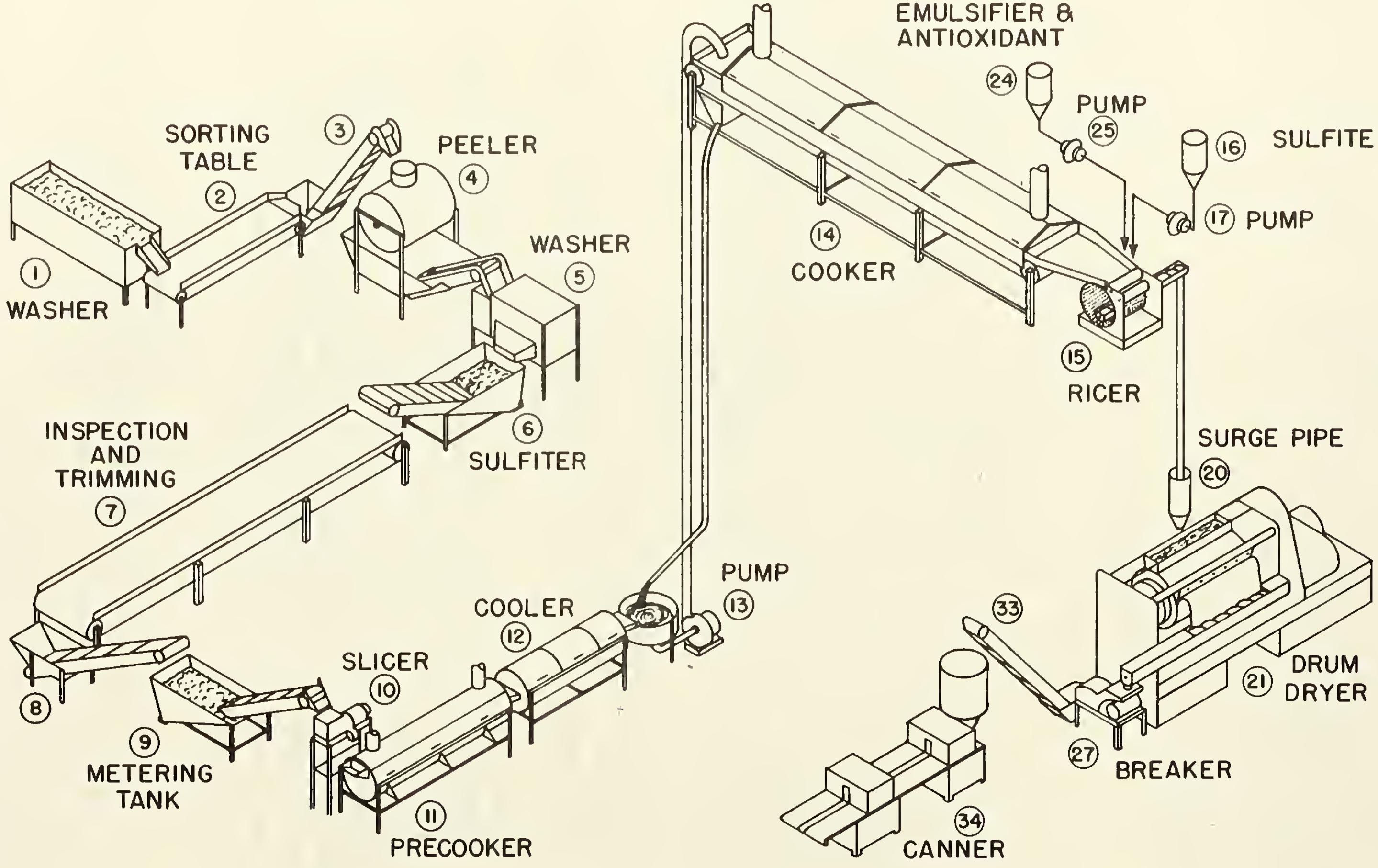

Fig. 2. Potato Flake Process

(E) Sulfite Addition

A dilute sulfite solution from a tank (Item 16) is incorporated into the mash at the ricer (Item 15) employing a pump (Item 17). The sulfite preserves flavor during drying and storage. The solution contains 1 part of sodium bisulfite and 3 parts of sodium sulfite dissolved in water to give 10% total solids. The amount added should give about 150 to 200 ppm (parts per million) of sulfur dioxide in the final product based on the solids. About 65% of the sulfite added is lost during the drying operations; hence excess sulfite must be added. For purposes of illustration, the estimated quantity of sulfite added to produce 800 pounds per hour of flakelets containing about 200 ppm of sulfur dioxide might be:

	0.205	pound per hour of sodium bisulfite
	.615	pound per hour of sodium sulfite
	7.38	pounds per hour of water
TOTAL	8.20	pounds per hour

It may be necessary to adjust the quantity added depending upon the loss of sulfite in drying the product.

(F) Antioxidant Addition

Antioxidant (if used) is added from a tank (Item 18) employing a pump (Item 19). The antioxidant can be Tenox IV[*] and is added to prolong shelf life. It contains 20% BHA (butylated hydroxyanisole) and 20% BHT (butylated hydroxytoluene); the remaining 60% is vegetable oils. The maximum permissible content of the two active ingredients (BHA plus BHT) in potato flakes is given in the Federal Register of September 2, 1961, page 8283. The tolerance in flakelets would have to be based on a separate petition to the Food and Drug Administration.

For cost estimation purposes only, it is assumed the flakelets would contain approximately 17 ppm of active ingredients on a dry basis. About 75% of the active ingredients is volatilized (and hence lost) at the drum dryer (Item 21). Furthermore, about 45% of what is left in the drum dried sheet is volatilized in drying the flakelets; hence excess antioxidant must be added to allow for these losses. Since the uniform incorporation of a minute quantity of antioxidant into a relatively large quantity of potatoes is difficult, the material is added as an emulsion. A small quantity of nonfat dry milk may be used to stabilize the emulsion.

[*] Reference to certain products or companies in this publication does not imply an endorsement by the Department over others not mentioned

The approximate quantities for producing 800 pounds per hour of flakelets are shown below; however, adjustments may have to be made depending upon the loss of antioxidant in plant operation.

Tenox IV	0.24 pound per hour
Nonfat dry milk	.40 pound per hour
Water	14.40 pounds per hour
TOTAL	15.04 pounds per hour

Tests are in progress to determine the shelf life of flakelets air-packed with antioxidant, and nitrogen-packed without antioxidant. The additional cost for packaging flakelets in nitrogen with and without antioxidant is given in section VII.

(G) Drum Drying

Item 20 is a small surge pipe to smooth out any variation in the feed to the drum drier (Item 21). In making flakes a drum dryer is usually operated at about 2 rpm to obtain 6% moisture in the product. However, it is generally practical to operate the drum at 6 rpm when making a sheet to be converted to flakelets. Moreover, the sheet is dried to only 8 to 10% moisture. The net result may be a 100% increase in drum dryer capacity over that normally obtained in making flakes.* Thus, a standard 4-ft. diameter by 10-ft. length dryer would produce 750 pounds per hour of sheet which, when broken and mixed with the right proportion of mash to give the desired moisture range, would yield 817 pounds per hour of flakelets containing 6% moisture. To allow for minor losses, the flakelet capacity is assumed to be 800 pounds per hour.

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*The use of early season potatoes or potatoes with less than about 21% solids may be conducive to the formation of hard balls, instead of laminates, during manipulation. This can be overcome by adding to the fraction that is to be drum dried a portion of the emulsifier normally incorporated in the cooler (Item 23). The emulsifier to be thus added can be blended in the antioxidant tank (Item 18). This addition need not necessarily reduce drum dryer capacity, for, when operating at 6 rpm, a steam pressure of about 110 pounds per square inch is employed. This produces a drum surface temperature sufficiently high to ensure good adhesion of the mash without the necessity for prior dilution.

In order to obtain a comparable cost for flakes made in a plant of the same capacity, a standard 5 by 16 ft. drum was chosen. This normally would produce 750 pounds per hour of flakes; however, it was assumed that this might be increased to 800 pounds per hour. Thus, the cost estimate shown for flakelets and flakes is based on plants having the same capacity, i.e., 800 pounds per hour.

In making flakelets, the sheet containing 8 to 10% moisture is broken into small pieces (Item 27), with a gentle action to prevent excessive rupture of the cells, and then conveyed (Item 28) to the mixer (Item 26).

(H) Cooling Mash Component

It was mentioned previously that the cooked slices are diverted into two streams; the relative proportion of the two is adjusted to give a mixture (Item 26) of about 30% moisture depending upon the variety of potatoes. The smaller stream from the cooker is riced (Item 22) and cooled to between about 70° and 100° F. (Item 23), since experimental work has shown that mash cooling prior to mixing gives a crumbly mash and avoids ball formation.

(I) Emulsifier Addition

The emulsifier is a distilled monoglyceride (Myverol type 18-07), a fully hydrogenated cottonseed oil, which is added to improve the texture of the reconstituted product (5). The amount added is usually 1-1/2% based on the solids in the product. This material as received is a solid in small bead form and, since the incorporation of a small quantity of solid in the mash is difficult, it is emulsified with water. Since the mix leaving Item 26 should have approximately 30% moisture, the amount of water used to make the emulsion should not be excessive, otherwise it reduces slightly the capacity of the plant, as shown by the data in Table 1.

TABLE 1. EFFECT OF WATER ADDED WITH MONOGLYCERIDES ON PLANT CAPACITY

Water added with monoglycerides	Estimated capacity of flakelet plant pounds/hour	Split-up of potatoes leaving cooker % to drum dryer	% to mixer
0	841	90.7	9.3
6-1/2 water to 1 --------	817	93.4	6.6
10 water to 1 -----------	805	94.8	5.2

The ratio of 6-1/2 of water to 1 of monoglycerides works well, but the emulsion should be kept between 90 and 105° F.; at lower temperatures it thickens and is difficult to pump; at higher than 110° it may gel. The emulsion can be made by using water at a temperature so that after adding the monoglyceride the temperature will be between 146 and 150° F. A high speed agitator in the mix tank should be turned on until the emulsion is formed and left on until the temperature drops to about 130° F. After the temperature has dropped to about 100° F., it can be transferred to the feed tank (Item 24). Additional information on making the emulsion can be obtained from the manufacturer (11).

As a guide only, the quantity of emulsifier that would be used in making 800 pounds per hour of flakelets is shown below:

Emulsifier	11.53 pounds per hour
Water	74.94 pounds per hour
TOTAL	86.47 pounds per hour

(J) Mixing of Broken Sheet with Mash Component

Mixing in Item 26 must be thorough. The broken sheet and mash are quickly and intimately blended so that (ideally) some mash adheres to each piece of the sheet. Good mixing is essential to prevent the formation of mash balls. In the pilot plant, 5-minute mixing in a J. H. Day Company, Model B, ribbon blender, was adequate. This mixer was a batch type with a double spiral and "cut in" fingers. A schematic drawing of it is shown in Figure 3. The equipment manufacturer will have to extrapolate to a continuous mixer, which will give the equivalent action achieved in 5 minutes batch mixing.

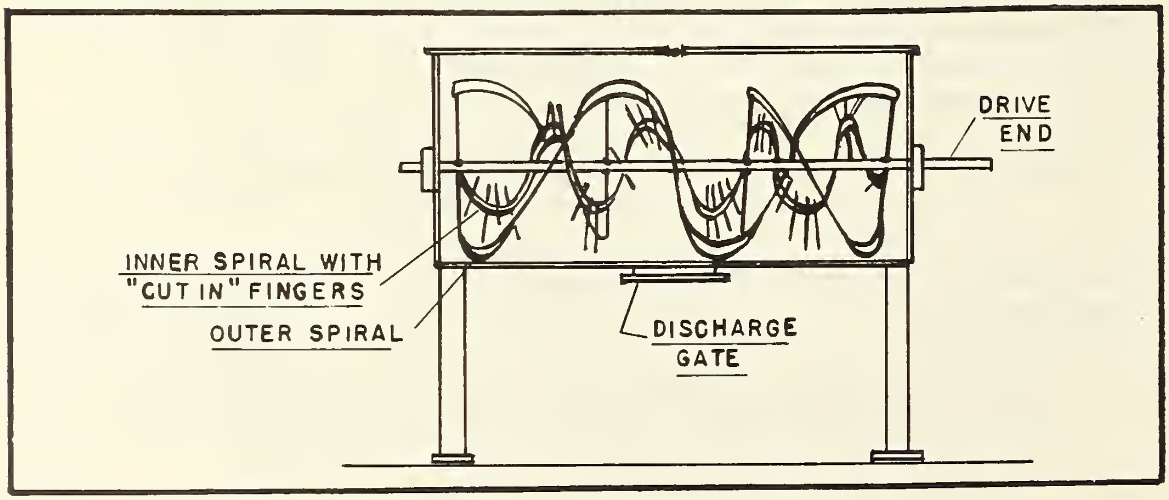


Fig. 3. Pilot Plant Batch Mixer

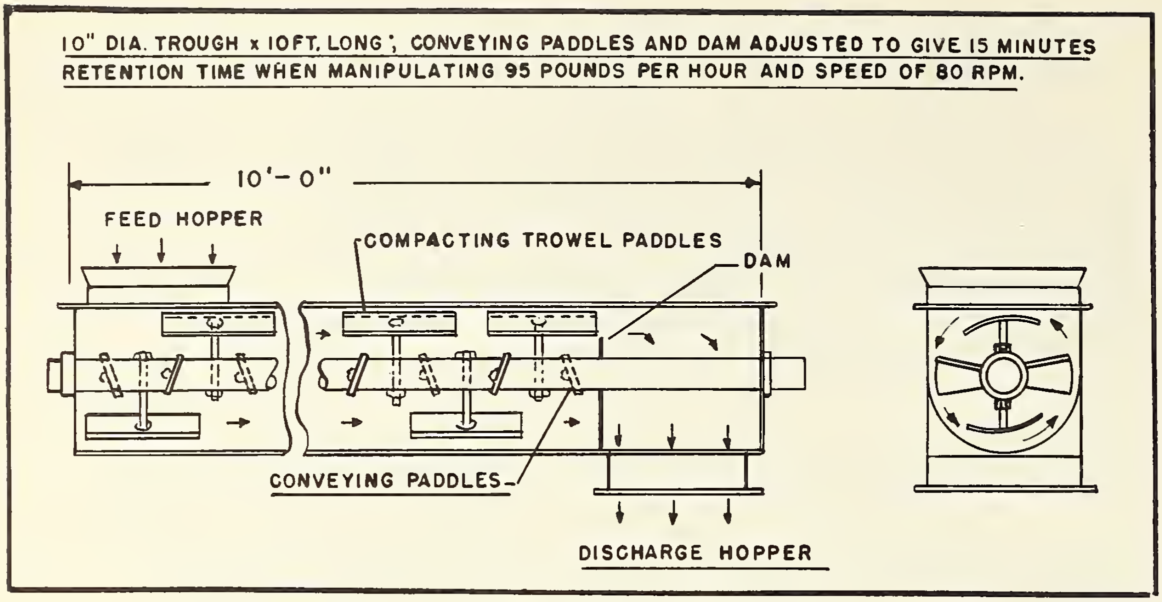
(K) Manipulating

The mixed material drops from the mixer (Item 26) into the manipulator (Item 29). This is the crux of the process. The term "manipulation" to describe the operation wherein the moist mixture of broken sheet and mashed potatoes is acted upon to markedly increase bulk density is less than definitive. It is difficult to find one word to describe the phenomenon responsible for the change in character produced in this step. Some pieces of the sheet are inevitably separated into smaller fragments but this is incidental and not essential to the increase in bulk density. When the sheet is broken the pieces change in two dimensions only; that is, their thickness remains the same, about 0.010 inch. However, when the broken sheet is converted into flakelets the pieces change in three dimensions, acquiring an increased thickness through lamination and aggregation. The function of the manipulator is to provide a gentle rubbing, compacting, and mixing action with minimum cell damage and to laminate the pieces without producing mash balls. Details of the continuous manipulator used in the pilot plant are shown in Figures 4 and 5. This was a paddle mixer-conveyor (pug mill) modified to produce the necessary compacting action. Alternate paddles were removed and replaced with specially constructed compacting paddles. These were arranged so that when rotating the advancing edge of each blade was at a greater clearance from the trough than the trailing edge; thus causing the material to be compacted by the compressing action produced during rotation. The pilot plant unit depicted in Figure 4 had a capacity of approximately 100 pounds per hour of moist product when the trailing edges of the compacting paddles were set at 1/4 inch with the trough and shaft speed (80 rpm) such as to give a peripheral speed of about 3 ft. per second at the trailing edge.

In a commercial unit the mixing paddles should permit adjustment to different angles, and a variable speed drive should be provided. The latter will permit convenient adjustments should they be necessitated by variations in raw material.

(L) Final Drying

From the manipulator the material is dried on a vibrating dryer (Item 30) to approximately 6% moisture. The data from the pilot plant dryers are given in Table 2. The results with dryer A are the best obtained in a dozen runs. Those from dryer B represent the best of 3 runs made in one day at the supplier's plant, and no doubt could be improved considerably with further experimentation.



10" DIA. TROUGH x 10FT. LONG; CONVEYING PADDLES AND DAM ADJUSTED TO GIVE 15 MINUTES RETENTION TIME WHEN MANIPULATING 95 POUNDS PER HOUR AND SPEED OF 80 RPM.

Fig. 4. Pilot Plant Manipulator

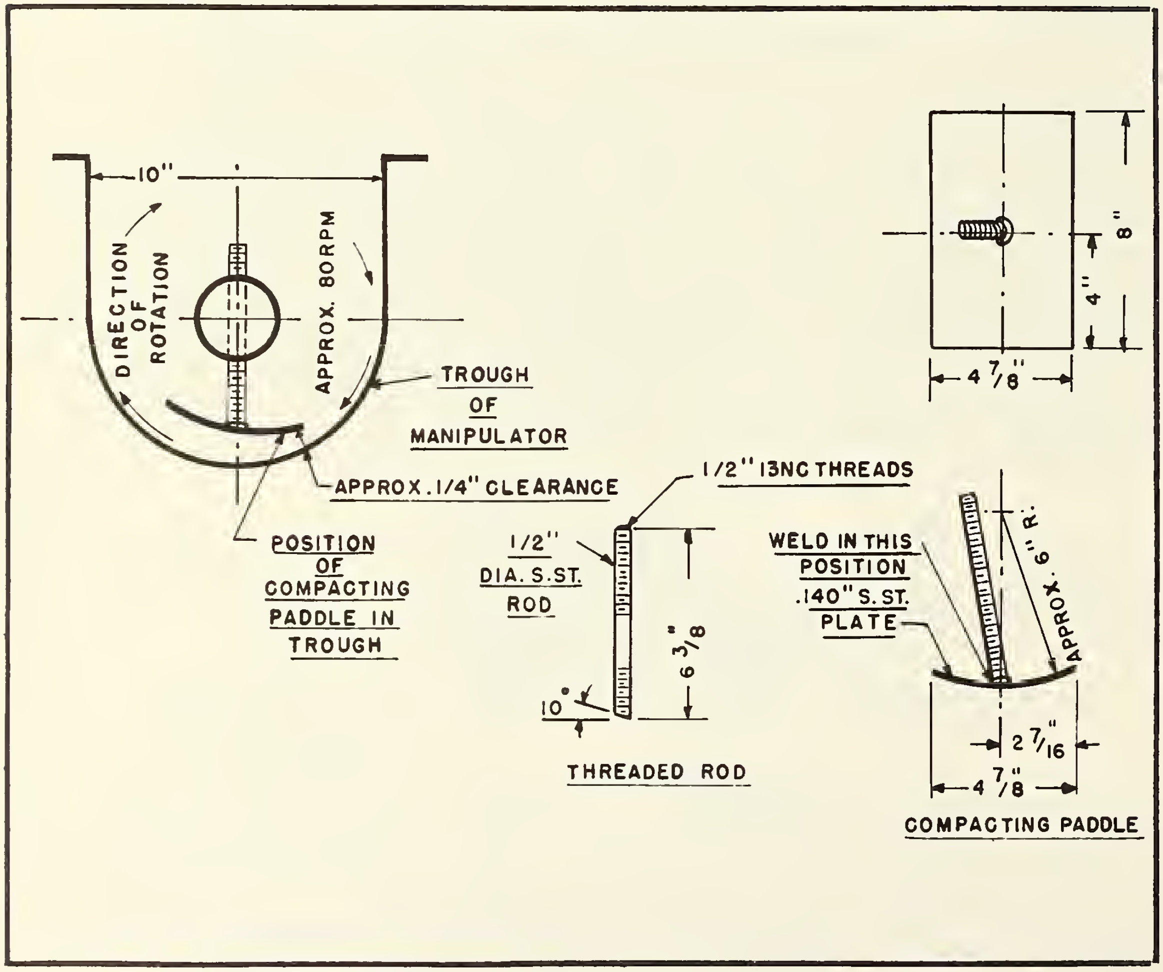


Fig. 5. Detail of Pilot Plant Manipulator

TABLE 2. VIBRATION DRYER

	Dryer A		Dryer B		
	1st pass	2nd pass	1st pass	2nd pass	3rd pass
Width of dryer bed inches	10-1/2			9	
Length of dryer bed feet	10			10	
Moisture in starting material %	27.2	11.3	29.8	19.6	9.4
Moisture in product %	11.3	5.4	19.6	9.4	5.6
Feed rate lb./hr.	380	490	330	330	330
Superficial air velocity [1] fpm.	104	104	120	120	120
Air temperature °F	260	260	230	230	230
Retention time on dryer bed seconds	47	45	30	30	34
Product temp - discharge end °F	148	190	126	160	184
Number of vibrations per second	---	---	750	750	750
Vibration stroke inch	3/32	3/32	3/16	3/16	3/16
Quantity collected in fine recovery system % of starting material	4.3		5.4		
Moisture in fines	---	---		10.0	
Moisture in final product (with fines included)	---	---		6.0	
Taste of reconstituted product	Normal; no scorching		Normal; no scorching (including fines)		

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[1] Total cross sectional area assuming no screen on dryer bed.

In dryer A the material was dried in approximately 90 seconds to below 6% moisture. In the pilot plant this required two passes of 10 ft. each. It could no doubt be dried in one pass of 20 ft. length. Dryer B required 3 passes to dry to less than 6% moisture in approximately 94 seconds, the extra pass presumably being the consequence of the lower temperature used. Extrapolation to a plant size dryer should be done by the dryer manufacturer.

(M) Packaging

Flakelets should be quickly cooled after drying. This can be done in a vibrating cooler (Item 31) similar to the dryer but much shorter. A fines recovery system for the cooler would not be required if the fines from the dryer are added to the cooled product. A single deck sifter (Item 32) should be provided to remove particles larger than 12-mesh; these usually amount to less than 2%. The product is then packed (with or without nitrogen) into No. 10 cans (Item 34). These cans hold about 5-1/4 pounds each.

III. BASIC ASSUMPTIONS FOR FLAKELET AND FLAKE PRODUCTION

(A) Plant Capacity

One drum dryer 4-ft. diameter by 10-ft. length should produce 817 pounds per hour of flakelets. A dryer of twice the area, e.g. 5-ft. diameter by 16-ft. length, should produce 750 pounds per hour of flakes. In order to make a direct comparison of the cost of the two products, a capacity of 800 pounds per hour was chosen for each.

(B) Conditioning Potatoes

Facilities are provided for conditioning the potatoes at 70° F. for 7 days when necessary to reduce their sugar content.

(C) Purchase of Potatoes

Field run potatoes containing 21% solids are assumed to be available at $1.50 per 100 pounds delivered to the processor's plant. No doubt, potatoes can be purchased at a lower cost in some parts of the country. The following quantity of potatoes would be processed for either flakelets or flakes.

Pounds per hour	6,000
Pounds per day	120,000
Tons per year	12,000

(D) Operating Time

The plant would operate 20 hours a day, which would allow 4 hours a day for cleanup. It would operate 6 days a week, 200 days a year.

(E) Losses

It would require on the average 7-1/2 pounds of potatoes to make 1 pound of either flakelets or flakes. One pound of either product could probably be made from 6 to 6-1/2 pounds of potatoes early in the season, but the ratio would increase later in the season depending upon how well the potatoes have been stored.

(F) Packaging

A No. 10 can will usually hold 5-1/4 pounds of flakelets or 2-1/2 pounds of flakes. Both products are assumed to be air-packed. The additional cost for nitrogen-packing flakelets is given in Section VII.

(G) Product

The following quantity of either flakelets or flakes would be produced:

Pounds per hour	800
Pounds per day	16,000
Pounds per year	3,200,000

(H) Facilities Available

Both the flakelet and the flake processes are considered to be an adjunct to an existing potato processing plant where other operations are carried on, such as packaging potatoes for retail markets, frozen French fries, hence, certain items will be in existence. They are charged to rent and not to fixed capital. If the processor does not have these facilities, the fixed capital required would be increased but the rent for them would be decreased correspondingly. Rent has been charged for the following: Conditioning building, processing building, boilers, land, site preparation, roads and parking areas, office equipment, and fire and safety equipment. In addition 1/3 of the following has been charged to flakelets or flakes on the basis that the remaining 2/3 could be charged to the other operations at the plant: Mechanic at $2.50 per hour, truck operator at $1.50 per hour, and 4 office employees totaling $15,000 per year.

IV. EQUIPMENT SUMMARY

A brief summary of the equipment required and the estimated price is given for both processes. These prices are estimates only, and the purchase price of any individual item may vary considerably depending upon the purchaser's specifications. The cost of the equipment was obtained from published sources or from suppliers.

The equipment capacities shown here represent average losses found by experience. These will vary widely depending on the variety and condition of potatoes used.

	Flakelets	Flakes
1. WASHER: For washing 6,000 pounds of potatoes per hour with water to remove soil; rotary rod type, 36-in. diameter by 12-ft. length with 2-hp motor and drive.	$3,850	$3,850
2. SORTING TABLE: For the removal of stones, rotten potatoes, and other extraneous material; rubber belt conveyor 24 in. wide by 10 ft. long (center to center of rolls). The price includes a 1-hp motor and drive.	1,450	1,450
3. CONVEYOR: To elevate potatoes to overhead hopper of steam peeler; rubber belt conveyor 18 in. wide by 15 ft. long with cleats and side boards. The price includes a 1-hp motor and drive.	1,700	1,700
4. PEELER: To soften the skin by putting approximately 300 pounds of potatoes into a batch type retort and using live steam under pressure for a short time, usually less than 2 min. A 1/2-hp motor is required to rotate the retort slowly. The peeler should have a capacity to peel 6,000 pounds of potatoes per hour.	12,000	12,000
5. WASHER: To wash off the skins by high pressure water sprays while the potatoes are tumbled. Included is a 1-hp motor drive. The price for Item 5 is included in Item 4.	---	---

	Flakelets	Flakes
6. SULFITER: To dip the potatoes in a solution of 1/2% of sodium bisulfite and 1/2% of citric acid to prevent darkening during inspection and trimming. This is usually a conveyor or rotating drum in a tank of stainless steel where in contact with potatoes. The price includes a 1-hp variable speed motor drive.	$3,700	$3,700
7. INSPECTION AND TRIMMING: For hand trimming and inspection of about 4,680 pounds per hour of peeled potatoes; rubber belt conveyor 36 in. wide by 15 ft. long (center to center) with 1-1/2 hp motor and drive.	2,500	2,500
8. CONVEYOR: To transfer about 4,080 pounds per hour of trimmed potatoes; rubber belt conveyor with cleats and side boards, 12 in. wide by 15 ft. long. The price includes a 1-hp motor.	1,600	1,600
9. METERING: To provide about 1/2 hour holding time (over lunch time for trimmers) and to control the processing rate to subsequent operations; hopper at inlet end; metering either by spiral screw or by belt conveyor with varispeed motor drive. The estimated price is for the latter type with 1/2-hp variable speed motor.	4,100	4,100
10. SLICER: Urschel type cutter to produce slices about 1/2 inch thick. The price includes a 2-hp motor.	2,800	2,800
11. PRECOOKER: To precook about 3,840 pounds per hour of sliced potatoes in water at 160° F. for 20 minutes; a stainless steel spiral screw conveyor enclosed in a stainless steel tank. The price includes a 3-hp variable speed drive.	7,400	7,400

	Flakelets	Flakes
12. COOLER: To cool potatoes below 100° F. by immersion for 40 minutes in flowing water; similar to Item 11, but longer.	$11, 100	$11, 100
13. PUMP: To pump about 3, 660 pounds per hour of slices in a stream of water; a food type centrifugal pump driven by a 10-hp motor at a constant speed which would not cause appreciable breakage of the slices.	1, 500	1, 500
14. COOKER: To cook about 3, 660 pounds per hour of 1/2-inch slices in atmospheric steam with a maximum of 45 minutes cooking time; stainless steel belt type with variable speed drive and adjustable splitter at discharge end to divert cooked potatoes into two streams when making flakelets.	33, 700	33, 700
15. RICER: To rice about 3, 420 pounds per hour of cooked slices by a gentle action which will not cause extensive cell rupture and release of free starch; usually a stainless steel spiral screw conveyor which forces the slices through slots with approximately 3/8-inch openings at the discharge end.	3, 700	3, 700
16. SULFITE TANK: To incorporate a dilute solution of sodium sulfite and sodium bisulfite into the mashed potatoes for preservation of color and flavor; for example, a 25-gal. stainless steel tank, preferably of 316 stainless to resist the corrosion of the sulfur dioxide evolved.	300	300
17. SULFITE METERING PUMP: Type 316 stainless steel metering pump with variable capacity for about 0.97 (gph). The price includes a 1/8-hp motor drive.	250	250

	Flakelets	Flakes
18. ANTIOXIDANT TANK: To incorporate antioxidant into mashed potatoes for extending shelf like of dried product; for example, a 25-gal. stainless steel tank with agitator to keep emulsion from separating.	$ 350	---
19. METERING PUMP: Stainless steel metering pump with variable capacity for about 1.8 gph. The price includes a 1/8-hp motor drive.	250	---
20. SURGE PIPE: To smooth out variations in flow to drum dryer; the cost of this item is included in piping and duct work in a tabulation headed "Capital Costs."	---	---
21. DRUM DRYER: One single drum dryer 4-ft. diameter by 10-ft. length. The drum would be fine grained cast iron capable of speeds between 2 and 6 rpm (the lower speed would be used only when making flakes in a flakelet plant). The price includes applicator rolls, discharge conveyor to break flakes, and hood with blower. Total connected motor load of 9 hp.	33,000	
Same, but 5-ft. diameter by 16-ft. length to operate at 2 rpm; total connected load of 11-1/2 hp.		42,400
22. RICER: To rice about 240 pounds per hour of cooked slices; similar to Item 15 but much smaller.	2,000	---
23. COOLER: To cool about 240 pounds of riced potatoes from about 200° F. to between about 70° and 100°; a jacketed, tubular mixing conveyor with adjustable paddles. Wiper blades will be necessary to keep potatoes from adhering to the housing. All parts in contact with product must be stainless steel, but the jacket can be plain steel.	3,100	---

		Flakelets	Flakes
24.	EMULSION TANK: (a) 150-gal. stainless steel tank with agitator to keep emulsion from separating and with coil for hot water to keep emulsion between 90° and 105° F.; (b) 150-Gal. stainless steel mixing tank with high speed agitator for preparing emulsion with hot water. Transfer from this tank to Item 24 can be by gravity flow.	$ 1,600	$ 1,600
25.	METERING PUMP: Stainless steel with variable capacity for 8.8 gph.	550	550
26.	MIXER: Continuous mixer for a total of about 1,100 pounds per hour with about 10 minutes retention time. It should have an outer ribbon mixer with "cut in" fingers and wipers to prevent mix from adhering to walls. It should also have adjustable paddles for conveying. A dam at discharge end may be necessary to insure sufficient retention time. (See Fig. 3 for schematic drawing of batch mixer used in pilot plant.)	3,300	---
27.	BREAKER: For flakelets, a breaker to cut about 760 pounds per hour of sheet, for example, a sharp knife hammermill equipped with screen having holes 1/4-inch diameter. The mill should break the flakes gently so that the fines produced will be a minimum.	3,500	
	For flakes, various means of breaking are used depending on the size and uniformity desired.		3,500
28.	ELEVATOR: A rubber belt conveyor can be used approximately 30 ft. long by 12 in. wide with cleats and side boards.	1,850	---

	Flakelets	Flakes
29. MANIPULATOR: The function of the manipulator is to provide a gentle rubbing, compacting, and mixing action with minimum cell damage, and to laminate the pieces of broken sheet without producing mash balls. In the pilot plant, a continuous pug mill was used. It had mixing paddles to toss the material back and forth; the angle of these paddles, together with a dam at the discharge end, were adjusted to give about 15 minutes retention time. Special trowel paddles gave the necessary compacting action. Figures 4 and 5 show the details of the pilot plant manipulator (see also discussion on page 1~~2~~1). The plant unit should have a capacity for manipulating about 1,100 pounds per hour.	$ 4,500	$ --
30. VIBRATING DRYER: Variable amplitude, vibrating dryer with hot air blown through the material as it is conveyed, in order to dry from initial moisture of about 30% to a final moisture of about 6%, with air temperature not to exceed 260° F. The conveying bed of the drier and the hood should be stainless steel. The remainder of the dryer can be plain steel. The drier should have a capacity to produce 800 pounds per hour of flakelets. A fines recovery system, such as a cyclone, will be required.	$15,700	---
31. VIBRATING COOLER: To cool 800 pounds per hour of product from about 190° to about 100° F. by using ambient air. It would be similar to Item 30 but much shorter and would not need a fines recovery system if they are reincorporated into the cooled product.	4,800	---
32. SIFTER: To screen out the small fraction of particles larger than 12 U.S. standard mesh; single deck sifter, capacity to screen 800 pounds per hour.	2,800	---

		Flakelets	Flakes
33. CONVEYOR: Rubber belt conveyor can be used approximately 15 ft. long by 12 in. wide with cleats and side boards.		$ 1,300	$ 1,300
34. PACKING: To air-pack 5-1/4 pounds of flakelets in No. 10 can, or 2-1/2 pounds of flakes.			
(a) hopper to hold 10 minutes supply	$ 250		
(b) table for filling cans	---		
(c) scale for weighing	150		
(d) conveyor for delivering cans past weighing station to can closer	690		
(e) semiautomatic can closer (the number of cans per hour would probably not warrant fully automatic machinery)	1,670		
(f) conveyor for placing 6 cans in a fiber carton using hand sealing.	690	3,450	3,450
		$173,700	$144,400

V. CAPITAL COSTS

		Flakelets	Flakes
1.	Equipment (see equip. summary)	$173,700	$144,400
2.	Erection of equipment (30% of Line 1)	52,100	43,300
3.	Piping and duct work (15% of Line 1)	26,000	21,600
4.	Erection of piping and duct work (70% of Line 3)	18,200	15,100
5.	Freight on equipment (2% of Line 1)	3,500	2,900
6.	Power installed (100% of motor cost to install motor plus $70/kw for transformers, etc.; total of 81 hp for flakelets and 55 hp for flakes)	9,900	6,500
7.	Instrumentation (minimum requirements)	2,400	1,700
8.	Transportation (fork lift truck)	4,000	4,000
9.	Insulation (necessary steam lines)	1,000	900
10.	Contingencies (10% of Line 13)	41,000	34,000
11.	Engineering fees (15% of Line 13)	61,500	51,000
12.	Contractor fees (4% of Line 13)	16,700	13,600
13.	Total Fixed Capital	410,000	339,000
14.	Working Capital*	295,000	305,000
15.	Total Capital	$705,000	$643,000

* Sum of (a) 1-month supply of raw materials, (b) 1-day supply of semi-finished material, (c) 1-week supply of finished material, (d) accounts receivable equal to sales of 1 month, and (e) operating cash equal to one month's cost to make.

VI. OPERATING COSTS

	FLAKELETS		FLAKES	
	dollars per day	cents per lb.	dollars per day	cents per lb.
I. FACTORY MANUFACTURING COSTS				
A. DIRECT PRODUCTION COSTS				
1. Raw Material				
Potatoes at $1.50/100 lb.	$1,800.00	11.25	$1,800.00	11.25
Emulsifier at 45 cents/lb.	103.77	.65	34.56	.22
Antioxidant at $1.57/lb.	7.54	.04	8.45	.05
Citric acid at 32 cents/lb.	4.79	.03	4.79	.03
Nonfat dry milk at 16 cents/lb.	1.32	.01	4.93	.03
Sodium bisulfite	1.26	.01	1.18	.01
Sodium sulfite	.83	.01	.58	.01
TOTAL RAW MATERIALS	1,919.51	12.00	1,854.49	11.60
2. Packing				
No. 10 cans at 12.151 cents each	370.36	2.32	777.64	4.86
Cartons to hold 6 cans at 12.919 cents per carton	65.63	.41	137.85	.86
TOTAL PACKING MATERIALS	435.99	2.73	915.49	5.72
3. Operating Labor				
(17 per shift for flakelets, 16 for flakes; 3 shifts per day)	766.10	4.79	707.20	4.42

	FLAKELETS		FLAKES	
	dollars per day	cents per lb.	dollars per day	cents per lb.
4. Indirect Labor				
Foreman - $3.00/hour	$ 72.00		$ 72.00	
Mechanic - 1/3 of 1 man's time	20.00		20.00	
Office help - 1/3 of 4 worker's time	25.13		25.13	
Truck operator -1/3 of 1 man's time	4.00		4.00	
TOTAL INDIRECT LABOR	121.13	.76	121.13	.76
5. Maintenance and Repairs (6% of total fixed capital per year)	123.00	.77	101.70	.64
6. Operating Supplies (15% of No. 5)	18.45	.11	15.26	.09
7. Utilities				
Steam at 80 cents/1,000 lb.	120.00	.75	111.04	.69
Electricity at 1.2 cents/kw-hr.	21.58	.14	14.73	.09
Water at 5 cents/1,000 gal.	7.15	.04	7.15	.04
TOTAL UTILITIES	148.73	.93	132.92	.83
DIRECT PRODUCTION COST (Sum of 1 - 7)	$3,532.91	22.08	3,848.19	24.05
B. FIXED CHARGES				
8. Insurance (1% of fixed capital)	20.50	.13	16.95	.11
9. Real Estate Taxes (2% of fixed capital)	41.00	.26	33.90	.21
10. Depreciation (10% of fixed capital)	205.00	1.28	169.50	1.06
11. Rent (see following section)				
For conditioning building	21.60	.14	21.60	.14
For processing building	110.25	.69	94.50	.59
For boilers	24.30	.15	23.13	.14
For miscellaneous services	5.10	.03	5.10	.03
TOTAL FIXED CHARGES (Sum of 8 - 11)	427.75	2.67	364.68	2.28

	FLAKELETS		FLAKES	
	dollars per day	cents per lb.	dollars per day	cents per lb.
C. Plant Overhead Costs				
12. Non-Wage Payments				
Social Security	22.43		20.71	
Workmens' Compensation	10.00		9.63	
Unemployment Insurance	51.14		47.21	
TOTAL NON-WAGE PAYMENTS	83.57	.52	77.55	.49
13. Miscellaneous Factory Expense	10.00	.06	10.00	.06
TOTAL PLANT OVERHEAD (Sum of 12 and 13)	93.57	.58	87.55	.55
TOTAL FACTORY MANUFACTURING EXPENSE (Sum of A, B, and C)	$4,054.23	25.34	$4,300.42	26.88
II. GENERAL EXPENSE				
D. INTEREST ON WORKING CAPITAL (5% for 300 days)	60.62	.38	65.75	.41
E. ADMINISTRATION AND GENERAL (3% of Total Manufacturing Expense)	121.63	.76	129.01	.81
TOTAL GENERAL EXPENSE (Sum of D and E)	182.25	1.14	194.76	1.22
III. COST TO MAKE (Sum of I and II)	$4,236.48	26.48	$4,495.18	28.09

RENT FOR FACILITIES USED IN FLAKELET PROCESS

	Conditioning Building	Processing Building	Boilers	Land	Site Prep.	Roads and Parking	Office Equip.	Fire and Safety Equip.
Size	50'x40' x 16' high*	110'x60' x 15' high**	9,400 lb. per hr. at 200 psi	4 acres				
Unit Price	$10.80/ sq.ft.	$19 per sq. ft.		$300		$3.50/ sq.yd.		
Cost	$21,600	$144,000	$27,000	$1,200	$3,000	$5,900	$3,500	$1,500
Charges								
Interest %	5	5	5	5	5	5	5	5
Taxes %	2	2	2	2	2	2	2	2
Insurance %	1	1	1	0	0	0	1	1
Depreciation %	6	3	4	0	0	10	8	10
Maintenance %	6	4	6	5	5	8	5	5
TOTAL %	20	15	18	12	12	25	21	23
Rent per yr.	$4,320	$22,050	$4,860	$144	$360	$1,475	$735	$345
Rent per operating day (200 days per yr.)	$21.60	$110.25	$24.30	1/3 charged to flakelets - Total of $5.10 per operating day.				

* Cost of conditioning building includes conveyor to bring potatoes into processing building.

** Second story for cooker 15' x 75' x 15' high.

RENT FOR FACILITIES USED IN FLAKE PROCESS

		Conditioning Building	Processing Building	Boilers	Miscellaneous Services
Size		50' x 40' x 16' high*	110' x 50' x 15' high**	8,350 lb. Per hour at 200 psi	
Unit price		$10.80/sq.ft.	$19/sq.ft.		
Cost		$21,600	$120,000	$25,700	
Charges					
Interest	%	5	5	5	Same as for flakelets, (including Land, Site preparation, Roads and parking, office equip., and Fire and Safety equip.)
Taxes	%	2	1	2	
Insurance	%	1	1	1	
Depreciation	%	6	3	4	
Maintenance	%	6	5	6	
TOTAL	%	20	15	18	
Rent per year		$4,320	$18,900	$4,626	
Rent per operating day (200 days per year)		$21.60	$94.50	$23.13	$5.10

* Cost of conditioning building includes conveyor to bring potatoes into processing building.

** Second story for cooker 15' x 75' x 15' high.

VII. ADDITIONAL COST FOR NITROGEN CANNING OF FLAKELETS

Since the high density of flakelets enables the use of a nitrogen pack more cheaply than is possible with flakes, estimates have been made of the additional cost to nitrogen pack flakelets. As can be seen below, this amounts to about 1/2 cent a pound additional with or without antioxidant added. Thus, flakelets packed in nitrogen would still cost approximately 1 cent a pound less than air packed flakes.

1. ADDITIONAL EQUIPMENT COST

(A) Hopper to hold flakelets	$ 250
(B) Scale for weighing flakelets	150
(C) Conveyor to deliver cans past weighing station	690
(D) Semiautomatic machine to clinch lids on cans but leave space for air to flow out and nitrogen to flow into cans	2,230
(E) Vacuumizing and gassing chamber to pull vacuum of 29 inches of mercury and break vacuum with nitrogen, operating on a 2-minute cycle	1,715
(F) Vacuum pump	1,300
(G) Semiautomatic can closer for final closing of lids	1,675
(H) Conveyor for inserting 6 cans in shipping container - hand sealing of cartons	690
TOTAL EQUIPMENT COST	$8,700
LESS EQUIPMENT COST FOR CANNING IN AIR	3,450
ADDITIONAL EQUIPMENT COST FOR NITROGEN CANNING	$5,250

2. ADDITIONAL FIXED CAPITAL

(I) Additional equipment	$5,250
(J) Erection of additional equipment 30% of (I)	1,575
(K) Additional piping and duct work 15% of (I)	788
(L) Erection of piping and duct work 70% of (K)	552
(M) Additional power installed	551
(N) Freight on additional equipment	105
(O) Contingencies, engineering fees, and contractor fees on additional equipment - 29% of Total	3,579
TOTAL	$12,400

3. ADDITIONAL OPERATING COSTS

(P) 1,000 cubic feet of nitrogen at $1.90/100 cubic feet	$19.00/day
(Q) Labor - one additional helper	42.90/day
(R) Maintenance and Repair 6% on $12,400	3.72/day
(S) Operating Supplies 15% of Maintenance and Repair	.56/day
(T) Electricity 83 kw-hr at 1.2 cents/kw-hr	1.01/day
(U) Fixed Charges - Insurance 1% - Taxes 2% - Depreciation 10% on $12,400	8.06/day
(V) Non-Wage payments on additional help	4.06/day
TOTAL	$79.31/day
LESS COST OF ANTIOXIDANT	3.93/day
ADDITIONAL COST	$75.38/day

	Cost per day	Pounds per day	Cost per pound
Additional cost to pack in nitrogen with antioxidant	$79.31	16,000	.50 cents
Additional cost to pack in nitrogen without antioxidant	75.38	16,000	.47 cents

VIII. PARTIAL LIST OF MANUFACTURERS OF EQUIPMENT

The companies listed below supply equipment which can be used in making flakelets. The item numbers refer to the flow sheet, Figure 1. Reference to these companies does not imply an endorsement of them by the Department over others not mentioned and failure to list other companies is not intentional.

Companies which MAY supply integrated plants are:

Blaw-Knox Co., P. O. Box 2041, Buffalo 5, N. Y.
Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

Companies which supply individual pieces of equipment are as follows:

1. Washer:

Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
F. H. Langsenkamp Co., 227 East South Street, Indianapolis 4, Ind.
Lockwood Grader Co., Gering, Neb.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

2. Sorting table:

Chisholm-Ryder Co., Inc., 5480 Highland Avenue, Niagara Falls, N. Y.
Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

3. Conveyor:

Same suppliers as for Item 2.

4. Peeler:

Chisholm-Ryder Co., Inc., 5480 Highland Avenue, Niagara Falls, N. Y.
Food Machinery & Chemical Corp., San Jose, Calif.
The Pfaudler Co., 1000 West Avenue, Rochester 3, N. Y.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

5. Washer:

Same suppliers as for Item 2 and also
Sinclair-Scott Co., 6245 State Road, Philadelphia 35, Pa.

6. Sulfiter:

Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

7. Inspection and Trimming:

Berlin Chapman Co., Berlin, Wis.
Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
A. K. Robins & Co., Inc., 713 East Lombard Street; Baltimore 2, Md.

8. Conveyor:

Same suppliers as for Item 2.

9. Metering:

Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

10. Slicer:

Food Machinery & Chemical Corp., San Jose, Calif.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.
Urschel Laboratories, Inc., 158 South Napoleon Street, Valparaiso, Ind.

11. Precooker:

Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.

Rietz Manufacturing Co., P. O. Box 847, Santa Rosa, Calif.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

12. Cooler:

Same suppliers as for Item 11.

13. Pump:

Fairbanks-Morse, 600 South Michigan Avenue, Chicago 5, Ill.
Food Machinery & Chemical Corp., San Jose, Calif.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

14. Cooker:

Berlin Chapman Co., Berlin, Wis.
Food Machinery & Chemical Corp., San Jose, Calif.
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
Rietz Manufacturing Co., P. O. Box 847, Santa Rosa, Calif.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

15. Ricer:

The standard machinery of most companies may need revision to avoid breaking of potato cells during ricing. The companies listed below have built ricers which were suitable for this purpose.

Overton Machine Co., 407 South Front Street, Dowagiac, Mich.
Rietz Manufacturing Co., P. O. Box 847, Santa Rosa, Calif.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.

16. Sulfite Tank:

Groen Manufacturing Co., 4535 Armitage Avenue, Chicago, Ill.
Lee Metal Products Co., 408 Pine Street, Phillipsburg 8, Pa.
The Pfaudler Co., 1000 West Avenue, Rochester 3, N. Y.

17. Metering Pump:

Hills-McCanna Co., 3025 North Western Avenue, Chicago 18, Ill.
Lapp Insulator Co., Inc., LeRoy, N. Y.
Milton-Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pa.
% Proportioneers, Inc., Providence, R.I.

18. Antioxidant Tank:

Same suppliers as for Item 16.

19. Metering Pump:

Same suppliers as for Item 17.

20. Surge Tank:

Any local supplier.

21. Drum Dryer:

The Black-Clawson Co., Hamilton, Ohio
Blaw-Knox Co., P. O. Box 2041, Buffalo 5, N. Y.
General Food Package Equipment Corp., 376 West Main Street, Benton Harbor, Mich.
Overton Machine Co., 407 South Front Street, Dowagiac, Mich.

22. Ricer:

Same suppliers as for Item 15.

23. Cooler:

J. H. Day Co., 4900 Beech Street, Cincinnati 12, Ohio
Idaho Falls Steel Products Co., 255 East Anderson Street, Idaho Falls, Idaho
Link Belt Co., 2045 West Hunting Park Avenue, Philadelphia, Pa.
Overton Machine Co., 407 South Front Street,Dowagiac, Mich.
A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.
Sprout-Waldron Co., Muncy, Pa.
The Young Machinery Sales Co., Inc., Robinson Division, Muncy, Pa.

24. Antioxidant and Emulsifier Tank:

Same suppliers as for Item 16.

25. Metering Pump:

Same suppliers as for Item 17.

26. Mixer:

Same suppliers as for Item 23.

27. Breaker:

The W. J. Fitzpatrick Co., 1001 West Washington Boulevard, Chicago 7, Ill.
Young Machinery Sales Co., Inc., Robinson Division, Muncy, Pa.

28. Conveyor:

Same suppliers as for Item 2.

29. Manipulator:

Same suppliers as for Item 23.

30. Vibrating Dryer:

Chain Belt Co., Carrier Division, 211 North Jackson Street, Louisville 2, Ky.
The Jeffrey Manufacturing Co., Columbus 16, Ohio
A. K. Robins & Co., 713 East Lombard Street, Baltimore 2, Md.
W. Richard Witte & Co., 13 East 21st Street, Linden, N. J.

31. Vibration Cooler:

Same suppliers as for Item 30.

32. Sifter:

A. K. Robins & Co., Inc., 713 East Lombard Street, Baltimore 2, Md.
Link Belt Co., 2045 Hunting Park Avenue, Philadelphia, Pa.
W. S. Tyler Company, 3614 Superior Avenue, Cleveland 14, Ohio
The Young Machinery Sales Co., Inc., Robinson Division, Muncy, Pa.

33. Conveyor:

Same suppliers as for Item 2.

34. Canning:

American Can Co., 230 Park Avenue, New York 17, N. Y.
Angelus Sanitary Can Machine Co., 4900 Pacific Boulevard, Los Angeles, Calif.
Continental Can Co., Inc., 100 East 42nd Street, New York 17, N. Y.

The following companies supply special chemicals:

Monoglycerides: (Myverol type 18-07)

Distillation Products Industries, Rochester 3, N. Y.

Antioxidant: (Tenox IV)

Eastman Chemical Products, Inc., Kingsport, Tenn.

IX. LITERATURE CITED

1. Cording, J., Jr., Willard, M. J., Jr., Eskew, R. K., Edwards, P. W., and Sullivan, J. F. "Potato flakes. A New Form of Dehydrated Mashed Potatoes. II. Some Factors Influencing Texture." U. S. Department Agriculture, Agricultural Research Service ARS-73-9 (1955).

2. Cording, J., Jr., Willard, M. J., Jr., Eskew, R. K., and Sullivan, J. F. "Advances in the Dehydration of Mashed Potatoes by the Flake Process." Food Technology, Vol. 11, No. 4, 236-240 (1957).

3. Cording, J., Jr., Sullivan, J. F., and Eskew, R. K. "Potato flakes. A New form of Dehydrated Mashed Potatoes. IV. Effect of Cooling After Precooking." U. S. Department of Agriculture, Agricultural Research Service ARS-73-25 (1959).

4. Kissinger, J. C. "A Procedure for the Bacteriological Examination of Potato Flakes." U. S. Department of Agriculture, Agricultural Research Service ARS-73-32 (1961).

5. Anonymous. "Further Improvement of Texture of Reconstituted Potato Flakes by Use of Emulsifiers." U. S. Department of Agriculture, Agricultural Research Service CA-E-17 (1959).

6. Anonymous. "Guides for Potato Flake Quality." U. S. Department of Agriculture, Agricultural Research Service CA-E-18 (1959).

7. Cording, J., Jr., "Vitamins in Potato Flakes." U. S. Department of Agriculture, Agricultural Research Service CA-E-29 (1960).

8. Eskew, R. K., Redfield, C. S., Cording, J., Jr., Willard, M. J., Claffey, J. B., Edwards, P. W., and Sullivan, J. F. "Potato flakes. A New Form of Dehydrated Mashed Potatoes. III. Estimated Commercial Costs." U. S. Department of Agriculture, Agricultural Research Service ARS-73-12 (1956).

9. Eskew, R. K., Drazga, F. H., Cording, J., Jr., Sullivan, J. F., and Woodward, C. F. "Potato Flakes. V. Potato Flakes of Increased Density." U. S. Department of Agriculture, Agricultural Research Service ARS-73-30 (1960). (Obsolete).

10. Eskew, R. K. Paper delivered at Twenty-First Annual Meeting of the Institute of Food Technologists, New York, May 7-11, 1961. (This paper is being processed.)

11. Eastman Kodak Company. Technical Bulletin, "Myverol Distilled Monoglycerides in Potato Flakes." Distillation Products Industries, Div. of Eastman Kodak Co., Rochester 3, N. Y.

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